# Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/US2005/020192

International filing date: 09 June 2005 (09.06.2005)

Document type: Certified copy of priority document

Document details: Country/Office: US
Number: 60/579,088
Filing date: 11 June 2004 (11.06.2004)

Date of receipt at the International Bureau: 24 May 2006 (24.05.2006)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

World Intellectual Property Organization (WIPO) - Geneva, Switzerland
Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse

1467878

# THE UNITED STATES OF AMERICA

## TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

*May 17, 2006*

**THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.**

**APPLICATION NUMBER:** *60/579,088*
**FILING DATE:** *June 11, 2004*
**RELATED PCT APPLICATION NUMBER:** *PCT/US05/20192*

**THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS** *US60/579,088*

UNITED STATES PATENT AND TRADEMARK OFFICE · DEPARTMENT OF COMMERCE

Certified by

Jon W. Dudas

Under Secretary of Commerce
for Intellectual Property
and Director of the United States
Patent and Trademark Office

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

22764 U.S.PTO 061104

15364 U.S.PTO 60/579088 061104

In re application of: Thomas J. Mortimer

Entitled: Single Platform Geolocation Methods

MAIL STOP PROVISIONAL PATENT APPLICATION
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

## PROVISIONAL APPLICATION COVER SHEET
(37 C.F.R. §1.51(2)(i))

### CERTIFICATION UNDER 37 CFR 1.10

I hereby certify that this correspondence and the documents referred to as attached therein are being deposited with the United States Postal Service on June 11, 2004, in an envelope as "EXPRESS MAIL POST OFFICE TO ADDRESSEE" service under 37 C.F.R. 1.10, Mailing Label Number EV333067017US, addressed to the: Mail Stop Provisional Patent Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Richard J. Musgrave

Richard J. Musgrave, Esquire

**This is a request for filing a PROVISIONAL APPLICATION under 37 CFR 1.53(c).**
**Inventor(s) (§1.51(c)(1)(ii):**

| Full Name of /First Inventor: Thomas J. Mortimer | | |
|---|---|---|
| City of Residence: Amherst | State or Country: New Hampshire | Country of Citizenship: U.S. |
| Post Office Address: 3 Roberts Road | City: Amherst | State or Country: New Hampshire — Zip Code: 03031 |

**Enclosed are:**
[X] 14 pages of specification (§1.51(c)(2)
[X] 1 sheet of informal drawings (one set) (§1.51(c)(3)
[ ] Power of Attorney
[ ] Assignment
[ ] Other:

[ ] Applicant claims small entity status (§1.9 and §1.27)

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government (§1.51(c)(1)(viii).
[x] No.
[ ] Yes, the name of the U.S. Government agency and the Government contract number are:

The filing fee, as set forth in 37 C.F.R. §1.16(k) is:
[ ] enclosed with a check in the amount of $____
[ ] not enclosed

[X] The Commissioner is hereby authorized to charge the filing fees under §1.16 associated with this communication to Deposit Account No. 19-0130.

**Attorney(s) and/or Agent(s):**

**Daniel J. Bourque, 35,457**
**Paul J. Kroon, Jr., 51,902**
**Richard J. Musgrave, 44,960**

**Address all correspondence to:**

**Bourque & Associates, P.A.**
**835 Hanover Street, Suite 301**
**Manchester, NH 03104**
**Telephone: (603) 623-5111**
**Facsimile: (603) 624-1432**

**Respectfully submitted,**

Richard J. Musgrave
Attorney of Record: Richard J. Musgrave, Esquire
Registration No. 44,960

June 11, 2004
Date

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

| | | |
|---|---|---|
| In re application | : | Thomas J. Mortimer |
| Serial No. | : | T/B/A |
| Filed | : | Herewith |
| For | : | Single Platform Geolocation Methods |
| Attorney's Docket | : | BAE-20020004PR |

I hereby certify that this correspondence is being deposited with the United States Postal Service as Express Mail No. EV33306701US in an envelope addressed to: Mail Stop Provisional Patent Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on June 11, 2004.

By Richard J. Musgrave
Richard J. Musgrave, Esquire
Registration No. 44,960
Attorney for Applicant(s)

**DEPOSIT ACCOUNT 190130 AUTHORIZATION**

Mail Stop Provisional Patent Application
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The Office is hereby authorized to charge the required fees in the total amount of $160, and charge any deficiency or credit any overpayment in the fees to the above deposit account, owned by BAE SYSTEMS Information and Electronic Systems Integration Inc., an

authorized signator for Kevin M. Perkins, V.P. & Company Counsel, and for whom the undersigned are authorized agents. Triplicate copies of this transmittal letter are enclosed.

Respectfully submitted,

BAE Systems Information and
Electronic Systems Integration Inc.

By Richard J. Musgrave

Richard J. Musgrave
Registration No. 44,960
Attorney for Applicants
Bourque & Associates, P.A.
835 Hanover Street
Suite 301
Manchester, NH 03101
Telephone: (603) 623-5111
Facsimile: (603) 624-1432

Date: June 11, 2004

Docket No.: BAE-20020004PR

# PROVISIONAL PATENT APPLICATION SPECIFICATION

## SINGLE PLATFORM GEOLOCATION METHODS

## TECHNICAL FIELD OF THE INVENTION

**[0001]** The present invention relates to single platform geolocation methods and more particularly to methods for determining a Doppler measurement set of a targeted aircraft via an electronic warfare aircraft and an aircraft expendables technology device.

## DESCRIPTION OF THE RELATED ART

**[0002]** Presently, there are methods that use dual platforms to obtain angle and range data relating to a radio frequency emitting energy source. The range is determined by an intersection on multiple lines of bearings. These methods are known as Differential Velocity Interferometry (DVI) techniques. Specifically, the Differential Velocity Interferometry (DVI) methods utilize a pair of electronic warfare aircraft flying at known velocities to compute a set of possible contours that satisfy an emitter location.

**[0003]** Obviously, a mission having two platforms is very expensive and complex. Further, the accuracy, proximate the

platforms, is not good. In addition, the mission geometries, such as platform separation, platform coordination, and platform timing are difficult to control. In summary, allocating and coordinating two electronic warfare aircrafts to perform an electronic warfare mission are complex and expensive tasks.

**[0004]** There is a need for a less complex and less expensive method of geolocating a target.

## SUMMARY OF THE INVENTION

**[0005]** Accordingly, the present invention provides novel methods for geolocating a target via a single platform. The methods are for accurately tracking a moving target without DF array and electronics.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0006]** These and other features and advantages of the present invention will be better understood by reading the following detailed description, taken together with the drawings wherein:

**[0007]** FIG. 1 is a single platform geolocation system showing an electronic warfare aircraft ejecting an aircraft expendables technology device for tracking a targeted aircraft, according to the present invention.

## DETAILED DESCRIPTION

**[0008]** The present invention is a variant of the Differential Velocity Interferometry (DVI) technique, which is a Doppler based location method. The present invention relates to methods for single platform geolocation. An electronic warfare aircraft 10, having an ejectable aircraft expendables technology device 12, such as a drone aircraft or similar device, is used to determine a Doppler measurement set of a targeted aircraft 14. For purposes of this specification, targeted aircraft includes manned or unmanned aircrafts, missiles and the like.

**[0009]** In use, the aircraft expendables technology device 12 is ejected from the electronic warfare aircraft 10. The electronic warfare aircraft 10 and the aircraft expendables technology device 12 are in communication with each other and determine the Doppler measurement set for the targeted aircraft 14 or other signal of interest.

**[0010]** The aircraft expendables technology device 12, such as POET, IDECM, etc.), has a COMS signal transponder for providing the Doppler measurement set of the targeted aircraft 14. The aircraft expendables technology device 12 has a receiver 16 that is tuned and programmed to the targeted aircraft 14 or signal of interest prior to ejection. The aircraft expendables technology device 12 has a transmitter 18 for establishing a data link to the electronic warfare aircraft 10.

**[0011]** In an alternative embodiment, the aircraft expendables technology device 12 may include a GPS receiver 19 for providing time and position reference information. The aircraft expendables technology device 12 has a short-term time reference, which is accurate. The short-term time reference could be from a clock or the time produced from the GPS.

**[0012]** The time and position references are used for time difference of arrival (TDOA) measurements (i.e., the time interval separating the arrival of signals). The aircraft expendables technology device 12 reports its flight position and time tagged signal of interest data to the electronic warfare aircraft 10. An on-board processor 20 in the electronic warfare aircraft 10 performs time difference of arrival geolocation computations.

**[0013]** In an alternative embodiment, telemetry between the electronic warfare aircraft 10 and the aircraft expendables technology device 12 is utilized to provide for re-tuning the receiver 16 in the aircraft expendables technology device 12 to multiple targeted aircraft 14 frequencies or signals of interest during its life. In an alternative embodiment, the aircraft expendables technology device 12 has a parachute or air braking system to slow down its descent to the ground when released or ejected from an ejection port 22 of the electronic warfare

aircraft 10; hence, the aircraft expendables technology device 12 will have a longer "hang time" or "air time".

**[0014]** To perform a single platform geolocation of the targeted aircraft 14, the electronic warfare aircraft 10 performs an initial frequency measurement of the targeted aircraft 14 or signal of interest. Thereafter, the receiver 16 in the aircraft expendables technology device 12 is tuned and programmed to the targeted aircraft 14 or the signal of interest, and the aircraft expendables technology device 12 is ejected from the ejection port 22 of the electronic warfare aircraft 10.

**[0015]** In the preferred embodiment, the receiver 16 of the aircraft expendables technology device 12 translates the frequency of the targeted aircraft 14 or the signal of interest to a new carrier frequency (e.g., 1 MHz or higher) and re-transmits it to the electronic warfare aircraft 10. In addition, a "pilot" frequency is transmitted from the aircraft expendables technology device 12 to the electronic warfare aircraft 10. The known "pilot" frequency provides a Doppler profile of the aircraft expendables technology device 12 from the time interval between its ejection from the ejection port 22 of the electronic warfare aircraft 10 and its touch down on the ground. The re-transmitted signal of interest with its unique view of the signal of interest Doppler, together with the

"pilot" Doppler, provide the electronic warfare aircraft 10 with the second Doppler data set for an emitter contour calculation.

**[0016]** One advantage for the receiving electronic warfare aircraft 10 is that it is equipped to process both the re-transmitted frequency of the targeted aircraft 14 or signal of interest and the "pilot" frequency. The electronic warfare aircraft 10 does not need to have additional receiving system hardware to process these signals. The aircraft expendables technology device 12 has expendable stores, a launcher, and a signal of interest programmer.

**[0017]** In a first alternative embodiment, the preferred embodiment is varied such that the "pilot" frequency modulates a difference beat frequency between the frequency of the targeted aircraft 14 or the signal of interest and the "pilot" frequency. The targeted aircraft 14 or signal of interest Doppler profile is easily extracted by the electronic warfare aircraft 10 by direct measurement of the "pilot" modulation frequency.

**[0018]** In a second alternative embodiment, the aircraft expendables technology device 12 is designed to measure the Doppler frequency shift between the initially programmed frequency and the received frequency of the targeted aircraft 14 or signal of interest. The aircraft expendables technology device 12 sends these numerical values back to the electronics warfare aircraft 10 via telemetry.

**[0019]** The present invention is less expensive and complex than the dual platform system. Further, the present invention has increased accuracy/large baseline, can track moving targets, needs no DF array and electronics, and requires only a single antenna, while the GPS provides an accurate platform location.

**[0020]** Modifications and substitutions by one of ordinary skill in the art are considered to be within the scope of the present invention, which is not to be limited except by the following claims.

FEATURES

The features of the present invention are:

1. A portable single platform geolocation method for determining a Doppler measurement set of a target of interest, comprising the features of:

providing an electronic warfare aircraft having an aircraft expendables technology device on-board, within a signal range of the target of interest;

performing an initial frequency measurement of the target of interest via the electronic warfare aircraft;

tuning and programming a receiver in the aircraft expendables technology device based on the initial frequency measurement of the target of interest;

ejecting the aircraft expendables technology device from the electronic warfare aircraft into airspace within the signal of range of the target of interest;

determining a Doppler measurement set on the target of interest by the aircraft expendables technology device; and

transmitting the Doppler measurement set of the target of interest from the aircraft expendables technology device to the electronic warfare aircraft.

2. The portable single platform geolocation method according to claim 1, further comprising the features of:

determining time and position references by the aircraft expendables technology device; and

transferring the time and position references from the aircraft expendables technology device to the electronic warfare aircraft.

3. The portable single platform geolocation method according to claim 2, further comprising the feature of utilizing the time and position references for determining a time difference of arrival measurement.

4. The portable single platform geolocation method according to claim 1, further comprising the features of:

determining flight position and time tagged signal of interest data using the aircraft expendables technology device;

transferring the flight position and time tagged signal of interest data to the electronic warfare aircraft; and

performing time difference of arrival measurements on the time tagged signal of interest data by the electronic warfare aircraft.

5. The portable single platform geolocation method according to claim 1, further comprising the feature of re-tuning a receiver of the aircraft expendables technology device

to a new target of interest in response to at least one received signal from the target of interest.

6. The portable single platform geolocation method according to claim 3, further comprising the feature of slowing the descent of the ejected expendables technology device.

7. The portable single platform geolocation method according to claim 3, further comprising the feature of translating a frequency of the target of interest to a new carrier frequency.

8. The portable single platform geolocation method according to claim 7, wherein the new carrier frequency is 1 MHz or higher.

9. The portable single platform geolocation method according to claim 7, further comprising the feature of transferring the translated frequency from the aircraft expendables technology device to the electronic warfare aircraft.

10. The portable single platform geolocation method according to claim 9, further comprising the features of:

determining a pilot frequency via the aircraft expendables technology device; and

transferring the pilot frequency from the aircraft expendables technology device to the electronic warfare aircraft.

11. The portable single platform geolocation method according to claim 10, further comprising the feature of providing a Doppler profile from a time interval via the pilot frequency from the aircraft expendables technology device to the electronic warfare aircraft.

12. The portable single platform geolocation method according to claim 11, further comprising the feature of providing the electronic warfare aircraft with a second Doppler data set via the translated frequency and the pilot frequency Doppler for an emitter contour calculation.

13. The portable single platform geolocation method according to claim 12, further comprising the feature of calculating the emitter contour calculation.

14. The portable single platform geolocation method according to claim 13, further comprising the feature of

processing the translated frequency of the target of interest and the pilot frequency.

15. The portable single platform geolocation method according to claim 13, further comprising the feature of modulating a difference beat frequency between the frequency of the target of interest and the pilot frequency.

16. The portable single platform geolocation method according to claim 15, further comprising the feature of determining a pilot modulation frequency.

17. The portable single platform geolocation method according to claim 13, further comprising the feature of measuring a Doppler frequency shift between the initial frequency and a received frequency of the target of interest.

18. The portable single platform geolocation method according to claim 1, wherein the target on interest includes an aircraft.

19. The portable single platform geolocation method according to claim 18, wherein the aircraft is manned.

20. The portable single platform geolocation method according to claim 18, wherein the aircraft is unmanned.

## ABSTRACT OF THE INVENTION

A geolocation method uses a single platform for determining a Doppler measurement set of a targeted aircraft or signal of interest. The electronic warfare aircraft and the ejected aircraft expendables technology device determine the Doppler measurement set of the targeted aircraft or other signal of interest. The ejected aircraft expendables technology device is initially tuned to an expected frequency of the target of interest. Re-tuning may take place after an initial signal reading and computation has been performed by the electronic warfare aircraft.

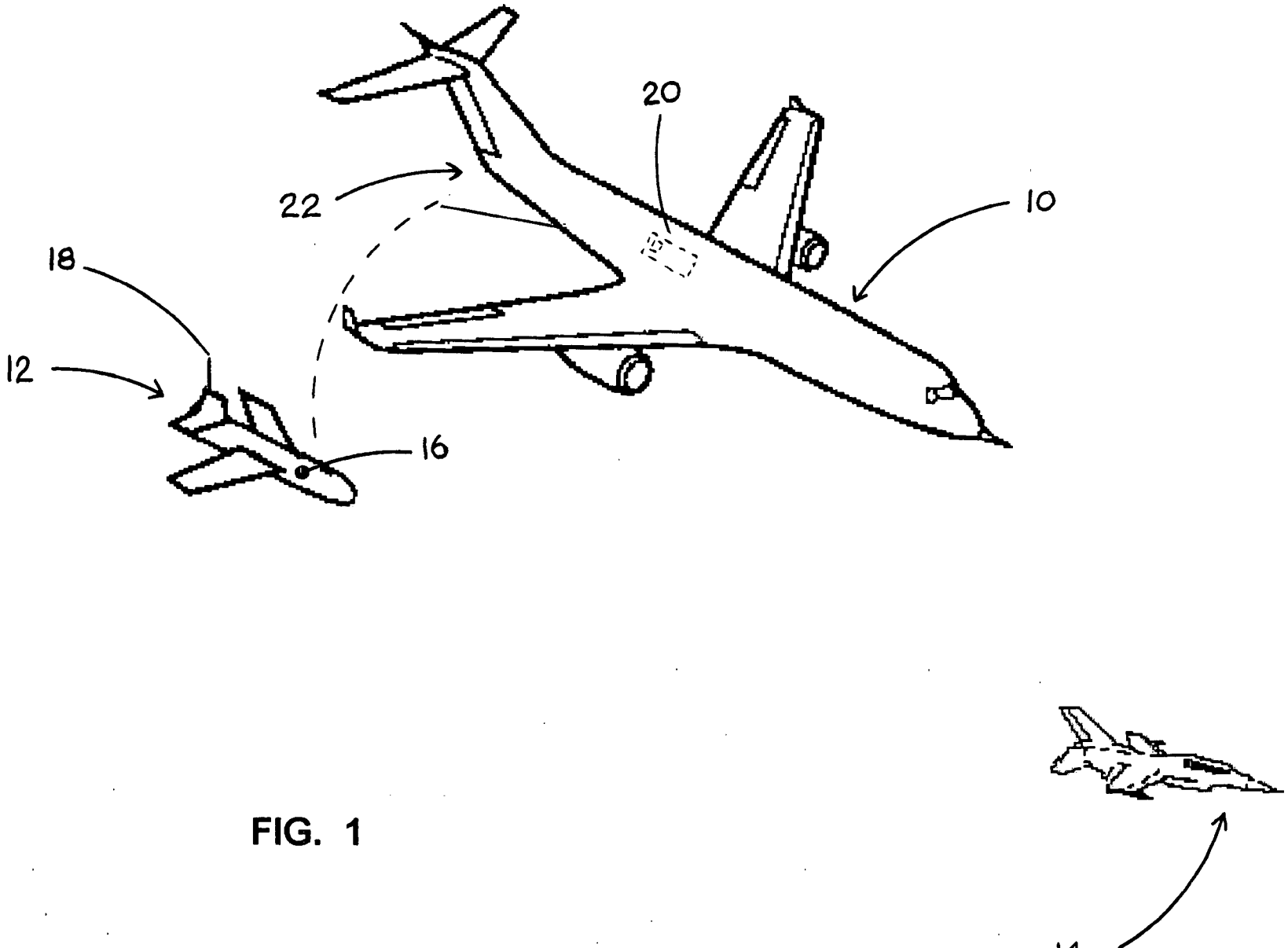


FIG. 1